Section 404. UNDERDRAINS

404.01 Description. This work consists of constructing and installing underdrains, foundation underdrains, prefabricated drainage systems (PDS), and underdrain outlets.

404.02 Materials. Materials shall meet the following requirements.

Mortar, Type R-2	702
Granular Material Class II	902
Open-Graded Aggregate 34R	902
End Sections	909
Pipe for Underdrains	909
Rodent Screens	909
Underdrain Outlets	909
Geosynthetics, PDS	910
Sod	917
Topsoil	917
Drainage Marker Posts	909

Pipe. Perforated pipe and tubing used for underdrains shall be wrapped in geotextile, except when used in conjunction with open-graded backfill material. Pipe and tubing used for underdrain outlet shall be non-perforated and need not be wrapped with geotextile. Where steel furnace slag is used for open-graded drainage course, the slot or hole size and water inlet area in the underdrain pipe shall be as follows:

Slot Width	$^{1}/_{16}$ inch to ⅛ inch
Hole Diameter	⅛ inch to $^{3}/_{16}$ inch
Water Inlet Area (min)	2 square inches per foot of tubing

Aggregate for Trench Backfill. The aggregate used to backfill the trench for an open-graded underdrain or prefabricated drainage system (PDS) shall be open-graded aggregate 34R. Granular material Class II shall be used as backfill for all other underdrains and underdrain outlets.

Outlet Endings. Outlet endings shall meet the requirements of section 909 and as specified in the plans. The outlet ending may be a concrete ring, a steel end section, or a concrete end section. Rodent screens shall be furnished for all outlet endings.

404.03 Construction. The plans will identify locations for underdrain and underdrain outlets, or will provide a miscellaneous quantity of pipe for use on the project. The exact line and grade of the underdrain will be as shown on the plans. The outlets shall be located at intervals shown on the plans and at locations which will ensure positive drainage.

A. **Excavating the Trench.** Excavate underdrain trenches using a wheel or chain trencher or other trenching methods approved by the Engineer. Trenches shall be excavated to the dimensions detailed on the plans. The trench bottoms shall be graded to the shape of the underdrain pipe.

PDS trench widths shall be 3 to 6 inches. A greater trench width shall be required if the backfill cannot be properly placed in the narrow trench due to wall collapse, or inability to obtain compaction.

Line trenches for open-graded underdrains with geotextile blanket according to the plans and specifications.

B. **Laying Underdrains.** Place the underdrains to the line and grade shown on the plans or to grades established by the Engineer. Pipes shall have firm bearing throughout the length of the pipe. Place 1 to 2 inches of open-graded aggregate 34R in the lined trench prior to pipe placement. Place compatible end caps on the upgrade ends of all underdrain pipes. Pipe which becomes either displaced from line and grade or damaged, shall be removed and relaid to the original grades.

Place PDS underdrain according to the plans and specifications. Equipment and materials are not allowed on the installed PDS until the open-graded drainage course is placed and approved by the Engineer.

PDS added at the edge of an existing pavement or as part of pavement rehabilitation shall be installed immediately adjacent to the edge of pavement to the depth shown on the plans or as directed by the Engineer.

C. **Connections.** All fittings and connection methods used in the underdrain system shall prevent separation of the pipes and shall be approved by the Engineer before underdrain installation begins. Fittings connecting the underdrain and outlet pipes shall be mechanically fastened with aluminum blind rivets, stainless steel self-tapping screws or interlocking parts. The self-tapping screws shall not penetrate the pipe inside diameter by more than ⅛ inch. Wrap all fittings with geotextile blanket and seal the geotextile to the outlet pipe with waterproof tape.

D. **Backfill and Compaction.** Backfill for trenches shall not be placed until the underdrain line and grade are approved by the Engineer.

1. **Foundation, Bank and Subgrade Underdrains and Underdrain Outlets.** Backfill foundation, bank, and subgrade underdrains and underdrain outlets with granular material class II as shown on the plans. Place the granular material around the pipe until the drain is covered to a depth of 12 inches. The remainder of the backfill shall be placed in layers not exceeding 12 inches. Compact the trench backfill material within the roadbed to 95 percent of maximum unit weight. Compact trenches outside the roadbed as directed by the Engineer. Where subgrade underdrain; open-graded; and bank underdrain, open-graded are called for on the plans, place the open-graded aggregate 34R as indicated on the plans and according to the requirements for open-graded underdrains.

2. **Open-Graded Underdrains.** Backfill pipe and PDS open-graded underdrains with open-graded aggregate 34R. Immediately after the backfill is placed, compact both the

backfill and surrounding grade material with a vibrating plate compactor. Compaction should commence along the shoulder side of the underdrain and progress toward the pavement. Do not operate the compactor directly above the underdrain.

The Contractor shall maintain the exposed underdrain and backfill in a clean and unobstructed condition. If the Engineer determines that the backfill is not clean, then the backfill shall be removed and replaced at the Contractor's expense. If the Engineer determines that the underdrain is obstructed, the Contractor shall clear the obstruction at the Contractor's expense.

E. **Underdrain Outlet.** Lay underdrain outlets according to the plans with a minimum 4 percent grade. Install the underdrain outlet a minimum of 4 inches above the receiving ditch or sewer flow line as shown on the plans. Do not backfill the outlet trench until approved by the Engineer. Underdrain outlets must be installed within 48 hours of adjoining longitudinal underdrains. The Contractor is responsible for marking and maintaining the outlets.

F. **Outlet Endings.** Locate the outlet endings according to the plans or as directed by the Engineer. Excavate areas to be sodded to a minimum depth of 4 inches and place topsoil and sod according to subsection 816.03. Install drainage marker posts according to subsection 401.03.H.

When underdrains are installed in conjunction with construction or resurfacing of concrete or HMA shoulders, the location of outlet endings is to be marked on the adjacent shoulder by a ½ inch deep, 4 by 6 inch depression with the long edge placed perpendicular to the edge of the shoulder. Other methods of marking locations may be approved by the Engineer.

1. The markers in concrete shoulders shall be stenciled into the concrete surface after texturing.

2. The markers in HMA shoulders shall be formed into the new warm HMA surface at the time of finish rolling. The method used to form the depression must be approved by the Engineer.

G. **Cleanout.** Underdrains and outlets installed on the project shall be maintained and kept free from accumulations of silt and debris until the time of final acceptance.

404.04 Measurement and Payment.

Contract Item (Pay Item)	**Pay Unit**
Underdrain, Subgrade, __	Foot
Underdrain, Bank, __ inch	Foot
Underdrain, Subgrade, Open-graded, __ inch	Foot
Underdrain, Bank, Open-graded, __ inch	Foot
Underdrain, Fdn, __ inch	Foot
Underdrain, Subbase, __ inch	Foot
Underdrain, Pipe, Open-graded, __ inch	Foot

Underdrain, PDS, Open-graded, __ inch . . . . . Foot
Underdrain, Edge of Pavt, __ inch . . . . . Foot
Underdrain Outlet, __ inch . . . . . Foot
Underdrain, Outlet Ending, __ inch . . . . . Each

Underdrains will be measured in place, by length in feet.

Underdrain Outlet will be measured in place, from the underdrain to the center of a drainage structure or from the underdrain to the end of the outlet pipe. The 3-foot radius or wyed section, as detailed in the plans, just prior to the outlet ending will be measured and paid for as the appropriate length of underdrain.

Payment for all types of **Underdrain** and **Underdrain Outlets** includes excavating the trench, furnishing and placing the pipe and fittings; furnishing, placing, and compacting the appropriate backfill material; and disposing of any surplus material excavated from the trench.

A. Payment for **Subgrade, Bank, Foundation,** and **Subbase Underdrains** also includes furnishing the pipe and fittings with a geotextile wrap.

B. Payment for **Underdrain, Open-Graded** also includes furnishing and lining the trench with geotextile.

C. Payment for **Underdrain, PDS, Open-Graded** also includes additional excavation and backfill where greater trench widths are required when backfill cannot be properly placed due to wall collapse or inability to obtain compaction.

D. Payment for **Underdrain Outlet** also includes exploration for lost outlets, if necessary, and maintenance of positive flow at the end of the outlet pipe (or end section), temporary tie-downs, and location markers.

E. Payment for **Underdrain, Outlet Ending** includes furnishing and placing the outlet ending (concrete ring, steel end section, or concrete end section), rodent screen, excavating the required area at the end of the outlet, furnishing and placing the topsoil and sod according to the plans, and the disposing of any surplus excavated material. The pipe or tubing used in or through the outlet ending will be measured and paid for as **Underdrain Outlet.** Payment also includes marking the location of outlet endings on the adjacent shoulder when required.

F. Drainage marker posts will be measured and paid for according to subsection 401.04.